OBSERVATIONS & RECOMMENDATIONS

After reviewing data collected from **Pawtuckaway Lake, Nottingham,** the program coordinators have made the following observations and recommendations.

Thank you for your continued hard work sampling the lake this year! Your monitoring group sampled the deep spot **five** times this year and has done so for many years! As you know, conducting multiple sampling events each year enables DES to more accurately detect water quality changes. Keep up the good work!

The New Hampshire Department of Environmental Services (DES), in conjunction with the U.S. Environmental Protection Agency (EPA) and the environmental consulting firm AECOM, conducted a Total Maximum Daily Load (TMDL) for total phosphorus for your lake. The TMDL refers to the pollutant reductions a waterbody needs to meet New Hampshire's water quality standards. Pawtuckaway Lake was listed on the 2008 impaired waters [303(d)] list because elevated algal growth impaired the primary contact recreation (swimming) use. Phosphorus is the nutrient responsible for algal growth and is the pollutant to be reduced to control algal growth. DES is required by the Federal Clean Water Act (CWA), Section 303(d), to report every two years to the EPA on all waters not meeting state water quality standards.

The TMDL conducted at your lake identified an in-lake target phosphorus value that, when met, should result in no additional primary contact recreation impairments due to algal growth. A phosphorus budget was constructed, phosphorus sources identified and phosphorus reductions allocated to each of the sources to meet the target value. An implementation plan provides recommendations on watershed remediation activities to reduce phosphorus inputs to the lake.

The draft TMDL will be provided to your lake association, town, and watershed stakeholders for review and will also be available on the DES website at www.des.nh.gov/organization/divisions/water/wmb/tmdl/index.htm. There will be a period for public review and comment, anticipated for Winter/Spring 2010. Phosphorus load reductions can only occur with the knowledge, participation and action of watershed residents, businesses and stakeholders. If you are interested in learning more about the TMDL Program please contact Peg Foss, TMDL Coordinator, at Margaret.foss@des.nh.gov or 603-271-5448.

As a result of phosphorus loading from tributaries and direct runoff, algal blooms and more specifically Cyanobacteria blooms have become more frequent in recent years. Cyanobacteria blooms have led to Pawtuckaway Lake as being listed on the EPA Section 303(d) list as impaired for primary contact recreation and not meeting state water quality standards.

To reduce algal blooms and eliminate Cyanobacteria blooms, phosphorus loading as a result of watershed runoff must be prioritized and addressed. In 2006, the Town of Nottingham, with support of the Pawtuckaway Lake Advisory Committee (PLAC) and Pawtuckaway Lake Improvement Association (PLIA) received a DES local watershed initiative grant to assist with this process. Pollutant load allocation will occur through the development of a watershed based plan. In addition, several shoreline properties will be selected for landscape best management practice (BMP) design and implementation targeted at reducing stormwater runoff rates and volumes through storage and infiltration. Geosyntec, Inc. was selected by DES to assist with development of the watershed based plan and BMP design. The Town of Nottingham has offered time and materials assistance to construct the BMPs.

In addition to the watershed based plan and BMP design and implementation the Town will lead an education campaign targeting landowners within the watershed about their individual impact on the watershed, stormwater runoff and the lake. Education will be accomplished through development and distribution of a Waterfront and Watershed property owner's brochure.

BMP recommendations for 12 sites were provided. A combination of Best Management Practices (BMPs) including stormwater diversion, velocity reduction, and infiltration, along with stabilizing road ditches with stone or erosion control matting were considered.

In 2008, PLAC, Geosyntec, Inc. and the Town of Nottingham finalized site selection for stormwater improvements. Two sites, Barderry Lane and Tuckaway Shores were selected for final design and construction. Improvements include road shoulder and ditchline stabilization, bioretention, and level spreaders for stormwater energy dissipation. Construction was completed in October, 2008 by the Town of Nottingham for a cost of approximately $22,000 which included labor and materials. The annual phosphorus load reduction estimate for Barderry Lane and Tuckaway Shores stormwater improvement sites totaled 4.0 kg per year.

A Weed Watcher refresher training was conducted at Pawtuckaway Lake during **2009**. Volunteers were trained to survey the lake once a month from **May** through **September**. To survey, volunteers slowly boat, or even snorkel, around the perimeter of the lake or pond and any islands it may contain. Using the materials provided in the Weed Watcher kit, volunteers look for any species that are suspicious. After a trip or two around the lake or pond, volunteers will have a good knowledge of its plant community and will immediately notice even the most subtle changes. If a suspicious plant is found, the volunteers immediately send a specimen to DES for identification. If the plant specimen is an exotic species, a biologist will visit the site to determine the extent of the problem and to formulate a management plan to control the nuisance infestation. Remember that early detection is the key to controlling the spread of exotic plants.

Volunteers from your lake participated in the Lake Host™ Program this year. The Lake Host™ Program is funded through DES and Federal grants. The program was developed in 2002 by NH LAKES and NHDES to educate and prevent boaters from spreading exotic aquatic plants to lakes in New Hampshire. Since then, the number of participating lakes and volunteers has doubled, the number of boats inspected has tripled, and the number of "saves" (exotic plants discovered) has increased from four in 2002 to a total of 297 in 2009. The program is invaluable in educating boaters and protecting NH's waterbodies from exotic aquatic plant infestations, thereby preventing recreational hazards, property value decline, aquatic ecosystem decline, aesthetic issues, and saving costly remediation efforts. Lake Host™ staff made **four** "saves" at your lake and discovered the following aquatic vegetation entering or leaving your lake in 2009:

Native milfoil (native)
Variable milfoil (exotic)
Fanwort (exotic)
Bladderwort (native)
Grassy spike rush (native)
Eurasian milfoil (exotic)
Coontail (native)
Tape grass (native)
Bur-reed (native)
Filamentous Green Algae (native)

Great work! We encourage volunteers to continue participating in the Lake Host™ Program to protect the future of your lake.

FIGURE INTERPRETATION

CHLOROPHYLL-A

- **Figure 1 and Table 1:** Figure 1 in Appendix A shows the historical and current year chlorophyll-a concentration in the water column. Table 1 in Appendix B lists the maximum, minimum, and mean concentration for each sampling year that the lake has been monitored through VLAP.

  Chlorophyll-a, a pigment found in plants, is an indicator of the algal abundance. Algae (also known as phytoplankton) are typically microscopic, chlorophyll producing plants that are naturally occurring in lake ecosystems. The chlorophyll-a concentration measured in the water gives biologists an estimation of the algal concentration or lake productivity. **The median summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 4.58 mg/m^3.**

  NORTH STATION
  The current year data (the top graph) show that the chlorophyll-a concentration ***increased gradually*** from **May** to **August**, and then ***decreased*** from **August** to **September**.

  The historical data (the bottom graph) show that the **2009** chlorophyll-a mean is ***slightly less than*** the state median and is ***slightly greater than*** the similar lake median. For more information on the similar lake median, refer to Appendix F.

  Overall, the statistical analysis of the historical data shows that the chlorophyll-a concentration has ***significantly increased*** (meaning ***worsened***) on average by ***approximately 2.354 percent*** per year during the sampling period **1988** to **2009**. Please refer to Appendix E for the statistical analysis explanation and data print-out.

  SOUTH STATION
  The current year data (the top graph) show that the chlorophyll-a concentration ***increased gradually*** from **May** to **July**, ***decreased*** from **July** to **August**, and then ***increased slightly*** from **August** to **September**.

  The historical data (the bottom graph) show that the **2009** chlorophyll-a mean is ***slightly less than*** the state median and is ***approximately equal to*** the similar lake median. For more information on the similar lake median, refer to Appendix F.

Overall, the statistical analysis of the historical data (the bottom graph) shows that the mean annual chlorophyll-a concentration has ***not significantly changed*** since monitoring began. Specifically, the mean annual chlorophyll-a concentration has ***fluctuated between approximately 3.01 and 10.63 mg/m³,*** but has ***not continually increased or decreased*** since **1992**. Please refer to Appendix E for a detailed statistical analysis explanation and data print-out.

While algae are naturally present in all lakes and ponds, an excessive or increasing amount of any type is not welcomed. In freshwater lakes and ponds, phosphorus is the nutrient that algae typically depend upon for growth in New Hampshire lakes. Algal concentrations may increase as nonpoint sources of phosphorus from the watershed increase, or as in-lake phosphorus sources increase. Therefore, it is extremely important for volunteer monitors to continually educate all watershed residents about management practices that can be implemented to minimize phosphorus loading to surface waters.

TRANSPARENCY

- **Figure 2 and Tables 3a and 3b:** Figure 2 in Appendix A shows the historical and current year data for transparency with and without the use of a viewscope. Table 3a in Appendix B lists the maximum, minimum and mean transparency data without the use of a viewscope and Table 3b lists the maximum, minimum and mean transparency data with the use of a viewscope for each year that the lake has been monitored through VLAP.

Volunteer monitors use the Secchi disk, a 20 cm disk with alternating black and white quadrants, to measure how far a person can see into the water. Transparency, a measure of water clarity, can be affected by the amount of algae and sediment in the water, as well as the natural lake color of the water. **The median summer transparency for New Hampshire's lakes and ponds is 3.2 meters.**

NORTH STATION

The current year data (the top graph) show that the non-viewscope in-lake transparency ***decreased*** from **May** to **July**, ***increased*** from **July** to **August**, and then ***decreased slightly*** from **August** to **September**.

It is important to note that as the chlorophyll concentration ***increased*** from **May** to **July**, the transparency ***decreased***. We typically expect this ***inverse*** relationship in lakes. As the amount of algal cells in the water increases, the depth to which one can see into the water column typically decreases, and vice-versa.

The historical data (the bottom graph) show that the **2009** mean non-viewscope transparency is ***slightly greater than*** the state median and is ***much less than*** the similar lake median. Please refer to Appendix F for more information about the similar lake median.

The current year data (the top graph) show that the viewscope in-lake transparency ***increased*** from **May** to **June**, ***decreased*** from **June** to **July**, and then ***increased*** from **July** to **September**.

The transparency measured with the viewscope was ***greater than*** the transparency measured without the viewscope this summer. A comparison of the transparency readings taken with and without the use of a viewscope shows that the viewscope typically increases the depth to which the Secchi disk can be seen into the lake, particularly on sunny and windy days. We recommend that your group measure Secchi disk transparency with and without the viewscope on each sampling event.

It is important to note that viewscope transparency data are not compared to a New Hampshire median or similar lake median. This is because lake transparency with the use of a viewscope has not been historically measured by DES. At some point in the future, the New Hampshire and similar lake medians for viewscope transparency will be calculated and added to the appropriate graphs.

Overall, the statistical analysis of the historical data shows that the non-viewscope transparency has ***significantly decreased*** (meaning ***worsened***) on average by ***approximately 0.703 percent*** per year during the sampling period **1988** to **2009**. Please refer to Appendix E for the statistical analysis explanation and data print-out.

SOUTH STATION

The current year data (the top graph) show that the non-viewscope in-lake transparency ***decreased*** from **May** to **July**, ***increased*** from **July** to **August**, and then ***decreased slightly*** from **August** to **September**.

It is important to note that as the chlorophyll concentration ***increased*** from **May** to **July**, the transparency ***decreased***, and as the chlorophyll concentration ***decreased*** from **July** to **August**, the transparency ***increased***. We typically expect this ***inverse*** relationship in lakes. As the amount of algal cells in the water increases, the depth to which one can see into the water column typically decreases, and vice-versa.

The historical data (the bottom graph) show that the **2009** mean non-viewscope transparency is ***slightly greater than*** the state median and is ***much less than*** the similar lake median. Please refer to Appendix F for more information about the similar lake median.

The current year data (the top graph) show that the viewscope in-lake transparency ***gradually decreased*** from **May** to **September**.

The transparency measured with the viewscope was ***greater than*** the transparency measured without the viewscope this summer. A comparison of the transparency readings taken with and without the use of a viewscope shows that the viewscope typically increases the depth to which the Secchi disk can be seen into the lake, particularly on sunny and windy days. We recommend that your group measure Secchi disk transparency with and without the viewscope on each sampling event.

It is important to note that viewscope transparency data are not compared to a New Hampshire median or similar lake median. This is because lake transparency with the use of a viewscope has not been historically measured by DES. At some point in the future, the New Hampshire and similar lake medians for viewscope transparency will be calculated and added to the appropriate graphs.

Overall, the statistical analysis of the historical data (the bottom graph) shows that the mean annual in-lake non-viewscope transparency has ***not significantly changed*** (either *increased* or *decreased*) since monitoring began. Specifically, the mean transparency has remained ***relatively stable, ranging between approximately 2.72 and 4.14 meters*** since **1992**. Please refer to Appendix E for the statistical analysis explanation and data print-out.

Typically, high intensity rainfall causes sediment-laden stormwater runoff to flow into surface waters, thus increasing turbidity and decreasing clarity. Efforts to stabilize stream banks, lake and pond shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the lake or pond should continue on an annual basis. Guides to best management practices that can be implemented to reduce, and possibly even eliminate, nonpoint source pollutants, are available from DES upon request.

TOTAL PHOSPHORUS

- **Figure 3 and Table 8:** The graphs in Figure 3 in Appendix A show the amount of epilimnetic (upper layer) phosphorus and hypolimnetic (lower layer) phosphorus; the inset graphs show current year data. Table 8 in Appendix B lists the annual maximum, minimum, and median concentration for each deep spot layer and each tributary since the lake has been sampled through VLAP.

Phosphorus is typically the limiting nutrient for vascular aquatic plant and algae growth in New Hampshire's lakes and ponds. Excessive phosphorus in a lake or pond can lead to increased plant and algal growth over time. **The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is 12 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.**

NORTH STATION
The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration ***decreased*** from **May** to **June**, ***increased*** from **June** to **July**, and then ***decreased*** from **July** to **September**.

The historical data show that the **2009** mean epilimnetic phosphorus concentration is ***slightly greater than*** the state and similar lake medians. Refer to Appendix F for more information about the similar lake median.

The current year data for the hypolimnion (the bottom inset graph) show that the phosphorus concentration ***increased*** from **May** to **June**, ***decreased*** from **June** to **July**, and then ***increased sharply*** from **July** to **September**.

The hypolimnetic (lower layer) turbidity sample was ***elevated*** on the **June, August and September** sampling events (**3.55, 21.9 and 13.5 NTUs**). This suggests that the lake bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling and/or that the lake bottom is covered by an easily disturbed thick organic layer of sediment. When the lake bottom is disturbed, phosphorus rich sediment is released into the water column. When collecting the hypolimnion sample, make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

The historical data show that the **2009** mean hypolimnetic phosphorus concentration is ***much greater than*** the state and similar lake medians. Please refer to Appendix F for more information about the similar lake median.

Overall, the statistical analysis of the historical data shows that the mean epilimnetic (upper layer) phosphorus concentration has ***significantly increased*** (meaning ***worsened***) on average by ***approximately 1.747 percent*** per year during the sampling period

1988 to **2009**. Please refer to Appendix E for the statistical analysis explanation and data print-out.

Overall, the statistical analysis of the historical data shows that the mean hypolimnetic (lower layer) phosphorus concentration has ***significantly increased*** (meaning ***worsened***) on average at a rate of ***approximately* 4.641 percent** per year during the sampling period **1988** to **2009**. Please refer to Appendix E for the statistical analysis explanation and data print-out.

SOUTH STATION
The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration ***decreased*** from **May** to **June**, ***increased*** from **June** to **July**, ***remained stable*** from **July** to **August**, and then ***increased*** from **August** to **September**.

The historical data show that the **2009** mean epilimnetic phosphorus concentration is ***slightly greater than*** the state and similar lake medians. Refer to Appendix F for more information about the similar lake median.

The current year data for the hypolimnion (the bottom inset graph) show that the phosphorus concentration ***decreased*** from **May** to **June**, and then ***increased*** from **June** to **September**.

The hypolimnetic (lower layer) turbidity sample was ***elevated*** on the **July, August and September** sampling events (**2.14, 9.8 and 4.51 NTUs**). This suggests that the lake bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling and/or that the lake bottom is covered by an easily disturbed thick organic layer of sediment. When the lake bottom is disturbed, phosphorus rich sediment is released into the water column. When collecting the hypolimnion sample, make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

The historical data show that the **2009** mean hypolimnetic phosphorus concentration is ***slightly greater than*** the state and similar lake medians. Please refer to Appendix F for more information about the similar lake median.

Overall, the statistical analysis of the historical data shows that the mean annual epilimnetic (upper layer) and hypolimnetic (lower layer) phosphorus concentration has ***not significantly changed*** (either *increased* or *decreased*) since monitoring began. Specifically, the mean annual epilimnetic and hypolimnetic phosphorus concentration has remained ***relatively stable*** (excluding 1999 hypolimnion data) since **1992**. Please refer to Appendix E for the statistical analysis explanation and data print-out.

One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about the watershed sources of phosphorus and how excessive phosphorus loading can negatively impact the ecology and the recreational, economical, and ecological value of lakes and ponds.

TABLE INTERPRETATION

- **Table 2: Phytoplankton**

  Table 2 in Appendix B lists the current and historical phytoplankton and/or cyanobacteria observed in the lake. Specifically, this table lists the three most dominant phytoplankton and/or cyanobacteria observed in the sample and their relative abundance in the sample.

  The dominant phytoplankton and/or cyanobacteria observed in the **North Station June** sample were ***Ceratium*** **(Dinoflagellate)**, ***Tabellaria*** **(Diatom)**, and ***Asterionella*** **(Diatom)**.

  The dominant phytoplankton and/or cyanobacteria observed in the **South Station June** sample were ***Ceratium*** **(Dinoflagellate)**, ***Dinobryon*** **(Golden-Brown)**, and ***Synura*** **(Golden-Brown)**.

  Phytoplankton populations undergo a natural succession during the growing season. Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding seasonal plankton succession. Diatoms and golden-brown algae populations are typical in New Hampshire's less productive lakes and ponds.

- **Table 4: pH**

  Table 4 in Appendix B presents the in-lake and tributary current year and historical pH data.

  pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 6.0 typically limits the growth and reproduction of fish. A pH between 6.0 and 7.0 is ideal for fish. The median pH value for the epilimnion (upper layer) in New Hampshire's lakes and ponds is **6.6**, which indicates that the state surface waters are slightly acidic. For a more detailed explanation regarding pH, please refer to the "Chemical Monitoring Parameters" section of this report.

The mean pH at the **North Station** deep spot this year ranged from **6.16** in the hypolimnion to **6.57** in the epilimnion. The mean pH at the **South Station** deep spot this year ranged from **6.12** in the hypolimnion to **6.56** in the epilimnion. This means that the water is ***slightly acidic***.

It is important to point out that the hypolimnetic (lower layer) pH was ***lower (more acidic)*** than in the epilimnion (upper layer) at the North and South Station. This increase in acidity near the lake bottom is likely due to the decomposition of organic matter and the release of acidic by-products into the water column.

Due to the state's abundance of granite bedrock in the state and acid deposition received from snowmelt, rainfall, and atmospheric particulates, there is little that can be feasibly done to effectively increase lake pH.

- **Table 5: Acid Neutralizing Capacity**

Table 5 in Appendix B presents the current year and historical epilimnetic ANC for each year the lake has been monitored through VLAP.

Buffering capacity (ANC) describes the ability of a solution to resist changes in pH by neutralizing the acidic input. The median ANC value for New Hampshire's lakes and ponds is **4.8 mg/L**, which indicates that many lakes and ponds in the state are at least "moderately vulnerable" to acidic inputs. For a more detailed explanation about ANC, please refer to the "Chemical Monitoring Parameters" section of this report.

The mean acid neutralizing capacity (ANC) of the **North Station** epilimnion (upper layer) was **4.4 mg/L** and the mean ANC of the **South Station** epilimnion was **4.8 mg/L**, which is ***approximately equal to*** the state median. In addition, this indicates that the lake is ***moderately vulnerable*** to acidic inputs.

- **Table 6: Conductivity**

Table 6 in Appendix B presents the current and historical conductivity values for tributaries and in-lake data. Conductivity is the numerical expression of the ability of water to carry an electric current, which is determined by the number of negatively charged ions from metals, salts, and minerals in the water column. The median conductivity value for New Hampshire's lakes and ponds is **40.0 uMhos/cm**. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

The mean annual epilimnetic conductivity at the **North Station** deep spot this year was **41.37 uMhos/cm**, and the mean annual epilimnetic conductivity at the **South Station** deep spot was **42.14 uMhos/cm** which is ***approximately equal to*** the state median.

The conductivity in the lake is relatively ***stable***. Typically conductivity levels greater than 100 uMhos/cm indicate the influence of pollutant sources associated with human activities. These sources include septic system leachate, agricultural runoff, and road runoff which contains road salt during the spring snow-melt. We hope this trend continues!

It is possible that de-icing materials applied to nearby roadways during the winter months may be influencing the conductivity in the lake. In New Hampshire, the most commonly used de-icing material is salt (sodium chloride).

Therefore, we recommend that the **epilimnion** (upper layer) be sampled for chloride next year. This additional sampling may help us identify what areas of the watershed are contributing to the increasing in-lake conductivity.

Please note that the DES Limnology Center in Concord is able to conduct chloride analyses, free of charge. As a reminder, it is best to conduct chloride sampling in the spring as the snow is melting and during rain events.

- **Table 8: Total Phosphorus**
  Table 8 in Appendix B presents the current year and historical total phosphorus data for in-lake and tributary stations. Phosphorus is the nutrient that limits the algae's ability to grow and reproduce. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

  The total phosphorus concentration was ***elevated*** and ranged from **1,300 to 3,200 ug/L** in **#09 Fernalds B** this year, and ranged from **330 to 600 ug/L** in **Fernalds A**. Turbidity levels in the **#09 Fernalds B** samples were also ***slightly elevated*** ranging from **2.43 to 6.42 NTUs**. This tributary system has had a history of ***elevated*** and ***fluctuating*** phosphorus concentrations, and the phosphorus concentrations have increased since monitoring began. It appears that agricultural practices in the tributary's sub-watershed have saturated the soils with phosphorus, ultimately causing the elevated concentrations in the tributary. We recommend that agricultural Best Management Practices (BMPs) be implemented and utilized at all agricultural establishments in the watershed. For more information on agricultural BMPs, please contact the State on NH's Department of Agriculture.

The total phosphorus concentration was ***elevated*** in the **Back Creek B and Mountain Brooks** this year. Due to the unusually high water levels and amount of rainfall during the spring and summer of **2009**, it is possible that watershed wetland systems released phosphorus-enriched water into the tributaries and ultimately into the lake.

The total phosphorus concentration was ***elevated*** in **White Grove Brook** this year, and more specifically White Grove Brook has experienced an ***increasing*** phosphorus trend since **2005**. Record summer rainfall likely increased stormwater runoff and nutrient loading to the tributary. As impervious surface cover increases in the watershed, stormwater runoff volumes increase. This transports phosphorus-laden stormwater into tributaries and eventually the lake. Efforts should be made in the watershed to reduce impervious surfaces and limit phosphorus sources such as fertilizer use, septic influences, agricultural impacts, and sediment/erosion control.

The total phosphorus concentration in **Fundy Brook** was ***elevated*** (**64 ug/L**) on the **September** sampling event. The turbidity of the sample was also ***elevated*** (**12.5 NTUs**), which suggests that the stream bottom may have been disturbed while sampling or that erosion is occurring in the watershed.

When the stream bottom is disturbed, phosphorus rich sediment is released into the water column. When collecting tributary samples, please be sure to sample where the tributary is flowing and where the stream is deep enough to collect a "clean" sample free from organic debris and sediment.

If you suspect that erosion is occurring in this area of the watershed, we recommend that your monitoring group conduct a stream survey and rain event sampling along this tributary. This additional sampling may allow us to determine what is causing the ***elevated*** levels of turbidity and phosphorus.

For a detailed explanation on how to conduct rain event sampling and stream surveys, please refer to the 2002 VLAP Annual Report special topic article, which is posted on the VLAP website at ***http://www.des.nh.gov/organization/divisions/water/wmb/vlap/categories/publications.htm****, or contact the VLAP Coordinator.*

- **Table 9 and Table 10: Dissolved Oxygen and Temperature Data**
  Table 9 in Appendix B shows the dissolved oxygen/temperature profile(s) collected during **2009**. Table 10 in Appendix B shows the

historical and current year dissolved oxygen concentration in the hypolimnion (lower layer). The presence of sufficient amounts of dissolved oxygen in the water column is vital to fish and amphibians and bottom-dwelling organisms. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

NORTH STATION
As previously mentioned, the hypolimnetic turbidity and total phosphorus concentrations were ***elevated*** on each of the sampling events this year. Historically, the hypolimnetic dissolved oxygen concentration has been ***low*** on most sampling events. This suggests that the lake bottom is composed of a thick layer of organic material that is easily disturbed. The presence of a thick organic layer on the lake bottom, likely comprised of decomposed plants and algae, would explain the lower dissolved oxygen concentration near the lake bottom.

SOUTH STATION
The dissolved oxygen concentration was ***high*** at all deep spot depths sampled in the lake on the **June** sampling event. Typically, shallow lake stations that are not deep enough to stratify into more than one or two thermal layers will have relatively high amounts of oxygen at all depths. This is due to continual lake mixing and diffusion of oxygen into the bottom waters induced by wind and wave action.

- **Table 11: Turbidity**
Table 11 in Appendix B lists the current year and historical data for in-lake and tributary turbidity. Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is strongly influenced by turbidity. Please refer to the "Other Monitoring Parameters" section of this report for a more detailed explanation.

As discussed previously, the North Station hypolimnetic (lower layer) turbidity was ***elevated*** (**3.55, 21.9 and 13.5 NTUs**) on the **June, August and September** sampling events, and the South Station hypolimnetic turbidity was ***elevated*** (**2.14, 9.8 and 4.51**) on the **July, August and September** sampling events. In addition, the hypolimnetic turbidity has been elevated on many sampling events during previous sampling years. This suggests that the lake bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling and/or that the lake bottom is covered by an easily disturbed, thick organic layer of sediment. When the lake bottom is disturbed, phosphorus rich sediment is released into the water column. When collecting the hypolimnion sample, make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

The turbidity in **#09 Fernalds B** samples was ***elevated*** throughout the season, which suggests that the stream bottom may have been disturbed while sampling or that erosion is occurring in this area of the watershed. When the stream bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column. When collecting tributary samples please sample where there's sufficient stream flow and depth to collect a "clean" sample free from debris and sediment.

The turbidity in the **Fundy Brook** sample was ***elevated*** (**12.5 NTUs**) on the **September** sampling event. The turbidity of the **White Grove Brook** samples was ***elevated*** (**4.67 and 7.94 NTUs**) on the **August and September** sampling events. This suggests that the stream bottom may have been disturbed while sampling or that erosion is occurring in this area of the watershed.

If you suspect erosion in the watershed, we recommend conducting a stream survey to identify sediment erosion. We also recommend that your monitoring group conduct rain event sampling along this tributary. This additional sampling may allow us to determine what is causing the ***elevated*** levels of turbidity.

*For a detailed explanation on how to conduct rain event sampling and stream surveys, please refer to the 2002 VLAP Annual Report special topic article, which is posted on the VLAP website at **http://www.des.nh.gov/organization/divisions/water/wmb/vlap/categories/publications.htm**, or contact the VLAP Coordinator.*

- **Table 12: Bacteria (*E.coli*)**
  Table 12 in Appendix B lists the current year and historical data for bacteria *(E.coli*) testing. *E. coli* is a normal bacterium found in the large intestine of humans and other warm-blooded animals. *E.coli* is used as an indicator organism because it is easily cultured and its presence in the water, in defined amounts, indicates that sewage **may** be present. If sewage is present in the water, potentially harmful disease-causing organisms **may** also be present.

  Bacteria sampling was not conducted this year. If residents are concerned about sources of bacteria such as failing septic systems, animal waste, or waterfowl waste, it is best to conduct *E. coli* testing when the water table is high, when beach use is heavy, or immediately after rain events.

- **Table 13: Chloride**
  Table 13 in Appendix B lists the current year and the historical data for chloride sampling. The chloride ion (Cl^-) is found naturally in some surfacewaters and groundwaters and in high concentrations in seawater. Research has shown that elevated chloride levels can be toxic to freshwater aquatic life. In order to protect freshwater aquatic life in New Hampshire, the state has adopted **acute and chronic** chloride criteria of **860 and 230 mg/L** respectively. The chloride content in New Hampshire lakes is naturally low, generally less than 2 mg/L in surface waters located in remote areas away from habitation. Higher values are generally associated with salted highways and, to a lesser extent, with septic inputs. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

  Chloride sampling was **not** conducted during **2009**.

- **Table 14: Current Year Biological and Chemical Raw Data**
  Table 14 in Appendix B lists the most current sampling year results. Since the maximum, minimum, and annual mean values for each parameter are not shown on this table, this table displays the current year "raw," meaning unprocessed, data. The results are sorted by station, depth, and then parameter.

- **Table 15: Station Table**
  As of the spring of 2004, all historical and current year VLAP data are included in the DES Environmental Monitoring Database (EMD). To facilitate the transfer of VLAP data into the EMD, a new station identification system had to be developed. While volunteer monitoring groups can still use the sampling station names that they have used in the past and are most familiar with, an EMD station name also exists for each VLAP sampling location. Table 15 in Appendix B identifies what EMD station name corresponds to the station names you have used in the past and will continue to use in the future.

DATA QUALITY ASSURANCE AND CONTROL

Annual Assessment Audit:

During the annual visit to your lake, the biologist conducted a sampling procedures assessment audit for your monitoring group. Specifically, the biologist observed the performance of your monitoring group and completed an assessment audit sheet to document the volunteer monitors' ability to follow the proper field sampling procedures, as outlined in the VLAP Monitor's Field Manual. This assessment is used to identify any aspects of sample collection in which volunteer monitors failed to follow proper procedures, and also provides an opportunity for the biologist to retrain the volunteer monitors as necessary. This will ultimately ensure samples that the volunteer monitors collect are truly representative of actual lake and tributary conditions.

Overall, your monitoring group did an ***excellent*** job collecting samples on the annual biologist visit this year! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the biologist to provide additional training. Keep up the good work!

Sample Receipt Checklist:

Each time your monitoring group dropped off samples at the laboratory this summer, the laboratory staff completed a sample receipt checklist to assess and document if your group followed proper sampling techniques when collecting the samples. The purpose of the sample receipt checklist is to minimize, and hopefully eliminate, improper sampling techniques.

Overall, the sample receipt checklist showed that your monitoring group did a ***very good*** job when collecting samples this year! Specifically, the members of your monitoring group followed the majority of the proper field sampling procedures when collecting and submitting samples to the laboratory. However, the laboratory did identify a few aspects of sample collection that your group could improve upon, as follows:

- **Sample bottle volume:** Please fill each sample bottle up to the neck of the bottle where the bottle curves in. This will ensure that the laboratory staff will have enough sample water to conduct all of the necessary tests.

  Please be careful to not overflow the small brown bottle used for phosphorus sampling since this bottle contains acid. If you do accidentally overflow the small brown bottle, please rinse your hands and the outside of the sample bottle and make a note of this on your field sampling sheet. The laboratory staff will put additional acid in the bottle in the laboratory to preserve the sample.

USEFUL RESOURCES

Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials, DES Booklet WD-03-42, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-03-42.pdf.

Erosion Control for Construction in the Protected Shoreland Buffer Zone, DES fact sheet WD-SP-1, (603) 271-2975 or http://des.nh.gov/organization/commissioner/pip/factsheets/sp/documents/sp-1.pdf

Lake Protection Tips: Some Do's and Don'ts for Maintaining Healthy Lakes, DES fact sheet WD-BB-9, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/bb/documents/bb-9.pdf.

Low Impact Development Hydrologic Analysis. Manual prepared by Prince George's County, Maryland, Department of Environmental Resources. July 1999. To access this document, visit www.epa.gov/owow/nps/lid_hydr.pdf or call the EPA Water Resource Center at (202) 566-1736.

Low Impact Development: Taking Steps to Protect New Hampshire's Surface Waters, DES fact sheet WD-WMB-17, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/wmb/documents/wmb-17.pdf.

*NH Stormwater Management Manual Volume 1: Stormwater and Antidegradation, DES fact sheet WD-08-20A, (*603) 271-2975 or http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-08-20a.pdf

NH Stormwater Management Manual Volume 2: Post-Construction Best Management Practices Selection and Design, DES fact sheet WD-08-20B, *(*603) 271-2975 or http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-08-20b.pdf

NH Stormwater Management Manual Volume 3: Erosion and Sediment Controls During Construction, DES fact sheet WD-08-20C, *(*603) 271-2975 or http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-08-20c.pdf

Proper Lawn Care In the Protected Shoreland, The Comprehensive Shoreland Protection Act, DES fact sheet WD-SP-2, (603) 271-2975 or http://des.nh.gov/organization/commissioner/pip/factsheets/sp/documents/sp-2.pdf.

Road Salt and Water Quality, DES fact sheet WD-WMB-4, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/wmb/documents/wmb-4.pdf.

Vegetation Maintenance Within the Protected Shoreland, DES fact sheet WD-SP-5, (603) 271-2975 or http://des.nh.gov/organization/commissioner/pip/factsheets/sp/documents/sp-5.pdf